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Wood by-Product as Storage Material for Post-Harvest Management of Tomato (*Solanum lycopersicum L.*) at Breaker Stage

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Authors' contributions

This work was carried out in collaboration among all authors. Author IOL designed the study, wrote the protocol and wrote the first draft of the manuscript. Author SAA performed the statistical analysis, and managed analysis of the study (TSS and Vitamin C). Author OBA managed analysis of the study (pH and TTA). Author ISA managed analysis of the study (Moisture Content, Lycopene and β-Carotene). Author ASI managed analysis of the study (Ash content and Mineral Analysis). Author TAF sourced for and identify the sample and monitored the weight changes. Author AYA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study evaluated the effect of wood by-product on the storability of fresh breaker tomato. The samples (*Kerewa variety*) were harvested, cooled by aeration and divided into three lots (B0=control; B1=1: 1, tomato: wood by-product; B2=1: 2, tomato: wood by-product). They were kept in uniformly sized paper carton (170 mm×120 mm×140 mm) on the shelf for 28 days. The organoleptic properties of the stored tomatoes were assessed on 5-point hedonic scale, as well as the physicochemical properties (moisture, pH, acidity, and soluble solids), carotenoids, vitamin C content and mineral analysis. Result showed that; B1 and B2 were significantly ($p<0.05$) higher

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than control in colour, appearance and overall acceptability while no significant ($p<0.05$) difference was observed between B1 and the control in firmness and odour. Weight or moisture loss (%) and decay incidence were higher in control than both B1 and B2. Moisture content (MC) reduced significantly ($p<0.05$) in sample B2 while no significant ($p>0.05$) difference was observed in control and B1 after 28 days storage. The pH of B1 was significantly ($p<0.05$) lower than B2 and the control but the β-carotene and vitamin C of B1 was significantly ($p<0.05$) higher than B2 and control. Wood by-product had shown some potentials for post-harvest handling of fresh breaker tomato most especially when used at ratio 1: 1 (w/w %).

Keywords: Storage material; post -harvest management; tomato; moisture content.

1. INTRODUCTION

Tomato (*Solanum lycopersicum L.*) is one of the most popular agricultural commodities cultivated and consumed worldwide in its raw and/or processed form. Tomato provides significant number of antioxidants to the human diet which includes lycopene, β-carotene, flavoniods, phenolics, vitamins C and E among others [1].

Highly perishable commodity such as tomato, with high moisture content and degradation rate, records a large annual loss which is detrimental to its nutritional and economic importance [2]. The high post-harvest losses of tomatoes can be attributed to microbial infection, physiological disorders and physical injuries that might occur during harvesting and transportation [3]. Tomatoes are harvested at matured stage and the major loss in its quality and quantity occurs at the gap between harvesting and consumption [2]. Harvesting stage determines the nutritional contents of tomato and as well influences consumers' preference on the fruit, judging from some sensory attributes such as the colour, firmness, taste and odour [4].

Wood ash is the by-product or left-over residue after the combustion of bark, wood chips, sawdust and cuttings of trees [5]. Quite a number of the mineral nutrients is retained in the ash except for nitrogen compound which are converted into gas in form of oxides and released to the atmosphere [6]. This study [6] further stated that wood ash, most times, does not contain high concentrations of heavy metals that pose a risk of secondary contaminations. This makes it safe for use in agricultural practices such as soil composites to aid growth of crops and storage practices. Wood ash has been employed in grain preservation and also in storage of tomato [7].

The high perishability of tomato has called for several methods of storage to prolong its shelf-life ensuring better quality retention in the fruit. A recent research publication by Fashanu et al. [8] demonstrated that wood ash had some positive impact on several quality indices of matured green tomato during short-time storage. However, it is a common practice in this part of the world to harvest tomato at breaker stage in order to compensate for distance and time between the farm and market so as to maintain the economic values. Hence, the present study was undertaken to investigate the influence of wood by-product (wood ash) on the storability of tomato at breaker stage and also to monitor its effect on physicochemical and nutritional properties as well as mineral contents and sensory attributes of the stored tomato.

2. MATERIALS AND METHODS

2.1 Reagents

All chemicals and reagents used for this work were of analytical grade products of SIGMA-ALDRICH, Germany and BDH, England, obtained from accredited distributors in Nigeria.

2.2 Collection and Preparation of Samples

Fresh breaker tomatoes (*kerewa* variety) used for this work was harvested from a farm within University of Ilorin, Nigeria. The sample was treated following the method described by Fashanu et al. [8]; briefly the sample was pre-cooled, washed and sorted. The sorted tomato was weighed and divided into three groups as follows:

B0=control, stored with no wood ash.
B1=1:1; tomato: wood ash (500g of breaker tomato stored with 500g of wood ash: w/w %).
B2=1:2; tomato: wood ash (500g of breaker tomato stored with 1000g of wood ash w/w %).

The treatments were stored in wood ash using a 170 mm x 120 mm x 140 mm paper carton as packaging material and the set-up were placed on the laboratory shelf for a storage period of 28 days under ambient condition (29°C temperature, 70% relative humidity).

Samples were subjected to physicochemical and nutritional analysis at interval of 7 days with day 0 being the initial while sensory and mineral analysis were carried out after the storage period.

2.3 Determination of Moisture Content

The moisture content determination was carried out adopting the [9] methods. A weighed portion (5 g) of homogenized tomato sample was dried in an oven to a constant weight first at 80°C for 4 h and subsequently at 105°C for 2 h.

2.4 Estimation of Weight Loss (%) and Decay Incidence (%)

Weight loss (%) was evaluated on daily basis by recording the total weight of each treatment and the differences in weight were used to estimate weight loss as follow;

$$\text{Weight loss } (\%) = \frac{W1 - W2}{W1} x100$$

Where;

W_1 = Initial weight
W_2 = Final weight

Decay incidence (%) was evaluated by recording the number of decayed fruits at 28th day of storage for all the treatments. The number of decayed tomatoes was divided by the total number of tomatoes initially packaged as illustrated below;

$$Decay\ incidence\ (\%) = \frac{Number\ of\ decayed\ fruits}{Total\ number\ of\ fruits} x100$$

2.5 Measurement of pH, Titratable Acidity (%) and Soluble Solid Content

The pH, titratable acidity and total soluble solid were determined using the method described by Sharoba [10] with little modification as follows; 10 g of sample was homogenized and centrifuged (5000 g, for 20 min), at 4°C. The supernatant was recovered for pH, titratable acidity, and soluble solids measurements. The pH was measured at 20°C with a pH meter (SEARCHTECH PHS-3C). Titratable acidity was determined by titrating with 0.1 N NaOH until pH 8.1 was reached (rose pink colour) and reported as gram citric acid/100 g fresh weight. Soluble solids content was determined at 20°C with a Refractometer (ABBE MARK II 10481; Cambridge Instrument Inc. NY) and reported as °Brix [10].

2.6 Determination of Vitamin C Content (mg/100 g)

Vitamin C content was determined using the 2,6-dichlorophenol indophenol titration method described by Ndawula et al. [11] with slight modification. 2 g of sample was homogenized in a mortar containing 10 ml of 0.5% oxalic acid (extraction solution) and the content transferred into 100 mL volumetric flask. More extraction solution was added up to the mark. The content was mixed thoroughly, filtered immediately using Whatman No. 4 filter paper and 10 mL aliquots of extract were titrated against standardized 2,6-dichlorophenol indophenol solution. An equivalent amount of the extraction solution was titrated against standard 2,6-dichlorophenol indophenol solution serving as a blank.

2.7 Lycopene and β-carotene Determination

As described by Sharoba [10], the tomato samples were homogenized using a mortar and pestle in the presence of water bath containing squash ice. Exactly 16mL of acetone–hexane (4:6) solvent were added to 1.0 g of the homogenate and mixed in a test-tube to extract the carotenoids. An aliquot of the upper solution from the two phases formed was taken and its absorbance was measured at 663, 645, 505, and 453 nm in a UV-VIS spectrophotometer (SEARCHTECH INSTRUMENTS; UV1902PC, ENGLAND). Lycopene and β-carotene contents for the tomatoes were calculated according to the [12] equations below as reported by Sharoba [10].

$$\text{Lycopene (mg per 100 mL)} = -0.0458 \text{ x A } 663 + 0.204 \text{ x A } 645 + 0.372 \text{ x A } 505 - 0.0806 \text{ x A } 453$$

$$\text{Beta Carotene (mg per 100 mL)} = 0.216 \text{ x A } 663 - 1.22 \text{ x A } 645 - 0.304 \text{ x A } 505 + 0.452 \text{ x A } 453$$

Where

A=Absorbance at specified wavelength

2.8 Mineral Analysis

The dry digestion methods described by Oshodi et al. [13] was adopted for the mineral analysis as follows; a weighed portion (1 g) dry matter of homogenized sample was taken into a crucible and placed in a muffle furnace at 600°C for 5 h to ash. The ash was cooled to room temperature in a desiccator and was dissolved in 10% hydrochloric acid (10 mL), filtered and diluted to 100 mL volume with distilled water. From the digest, various elements were determined; Na and K were measured by the use of Jenway digital flame photometer as described by [14]. Ca, Mg, Fe, Cu, and Zn were measured using atomic absorption spectrophotometer (AAS 969 Bulk Scientific VGP 210) in accordance with [9] and compared with absorption of standards of the elements. Heavy metal; Cr, Pb, and Cd were also measured according to [9].

2.9 Sensory Evaluation

The tomato samples were presented to 20-member untrained panelists, who are conversant with tomatoes, to evaluate the colour, appearance, firmness, odour and overall acceptability of the stored tomatoes using a five-point hedonic scale as described by Larmond [15].

2.10 Statistical Analysis

The experiments were carried out in triplicate and arranged in completely randomized design (CRD), with each consisting of fruit of relative weight for each observation. The data was subjected to analysis of variance (ANOVA) and tested for significance difference among treatments by New Duncan's Multiple Range F-Test (DMRT) at ($p<0.05$) using SPSS software package version 20.0.0 (IBM SPSS Statistics, IBM Corporation 2011. Armonk NY. USA).

3. RESULTS AND DISCUSSION

3.1 Sensory Attributes

The effect of wood by-product on the sensory attributes (colour, appearance, firmness, odour and overall acceptability) of breaker tomatoes after storage is as shown (Table 1). There was no significant ($p>0.05$) difference between the two treatments B1 and B2 in all the attributes tested. Also, both samples B1 and B2 were rated higher than the control (B0) in colour, appearance and overall acceptability with a significant different ($p<0.05$), whereas no significant ($p>0.05$) difference was observed between sample B1 and the control in firmness and odour. The results of sensory evaluation under the present review for breaker tomato showed some similarities although with little deviation from what was observed for matured green tomato as reported by Fashanu et al. [8]. Unlike in the case of matured green tomato where the control sample was rated lower in all the attributes, there was no significant ($p>0.05$) difference between control and B1 in firmness and odour.

3.2 Weight/Moisture Loss (%) and Decay Incidence (%)

The effect of wood by-product on the weight or moisture loss (%) of breaker tomato is as shown (Fig.1 a). The moisture loss ranged from 11.94-40.30, 0.65-11.79 and 0.41-10.49% for control, B1 and B2 respectively. These observations showed that; control sample lost as high as 40.30% of its original weight at the end of 28 days storage under ambient conditions where samples B1 and B2 berried in wood by-product lost only 11.79% and 10.49% respectively of their initial weights. The results thus demonstrated that; the higher the weight of wood by-product used, the lower the moisture loss. These results were similar to the observation of Fashanu et al. [8] when matured green tomato was stored with the same wood by-product. Moisture loss in fruit can be attributed to evapotranspiration that exist between the fruits and the surrounding atmosphere as reported by Maftoonazad and Ramaswamy [16]. It could also be as a result of the conversion of starch to sugars as sugars are less dense compared to starch in molecular weight [17].

The effect wood by-product on the decay incidence (%) of breaker tomato after storage is as shown (Fig. 1b). The record showed that decay incidence in control, B1 and B2 were 27.66, 7.04 and 11.43% respectively. The lowest decay incidence (%) was recorded in the treatment with lowest wood by-product. Similar result was obtained by [18] where Rubi grapes were treated with abscisic acid at different concentration levels. Unlike in the case of moisture loss where increase in the weight of wood by-product reduced the rate of moisture loss; here, an increase in the weight of wood ash caused higher decay incidence. Similar results were as well obtained when matured green tomato was stored using wood by-product [8].

Table 1. Effect of wood by-product on the sensory attributes of breaker tomato (*Solanum lycopersicum*L.) after storage

Sample	Colour	Appearance	Firmness	Odour	Overall acceptability
B0	2.20[b]	2.05[b]	2.35[b]	3.15[b]	2.45[b]
B1	3.45[a]	3.25[a]	2.90[ab]	3.70[ab]	3.35[a]
B2	3.85[a]	3.35[a]	3.05[a]	3.80[a]	3.30[a]
LSD	0.56	0.61	0.57	0.58	0.56

Readings show mean of 20 panellists on a 5-pont hedonic scale where 5 indicates like extremely and 1 indicates dislike extremely. B0=control, B1=ratio 1:1 (tomato: wood ash), B2=ratio 1: 2 (tomato: wood ash)

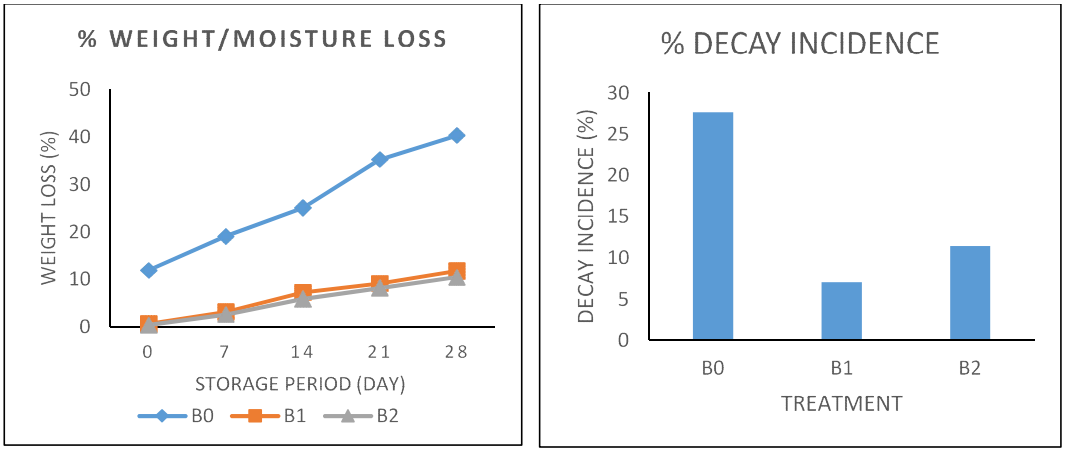

Fig. 1. Effect of wood by-product on the moisture/weight loss (a) and decay incidence (b) of breaker tomato (*Solanum lycopersicum*L.) after 28 days

3.3 The pH and Titratable Acidity (TA)

Generally, pH is a measure of the degree of acidity in a fruit [19]. The effect of wood by-product on pH (Fig. 2a) showed that the pH ranged from 5.25-5.12, 5.13-5.01 and 5.20-5.11 for B0, B1 and B2 respectively. There was significant ($p<0.05$) drop in pH of B2 between day 0 and day 7 while that of B0 and B1 dropped significantly ($p<0.05$) between day 0 and day 14. This is a desirable effect because decrease in pH corresponds to increased acidity, which subsequently favours reduced microbial growth except for acidophilic organisms. Notwithstanding, there was increase in pH of B2 from day 7 to 28 and those of B0 and B1 from day 14 to 28. This might indicate spoilage within those stipulated time. The findings also corroborated the report by [19] where there was an increase in the pH of coated breaker tomatoes stored for a period of 20 days.

The effect of wood by-product on the titratable acidity (TA) of breaker tomato during storage is as shown (Fig. 2b). The TA of control, B1 and B2 ranged from 0.82-2.64, 0.94-3.04 and 1.10-2.89 % respectively. There was a significant ($p<0.05$) increase in the TA of control, B1 and B2 from day 0 to day 21, followed by a sharp significant ($p<0.05$) decrease observed on day 28. Titratable acidity explains the measure of the amount of the dominant acid (Citric acid for tomato) present in a fruit [20]. The results of TA were in agreement with that of pH because increase in TA of the fruits corresponds with the decrease pH values. Judging from this point of view (results of TA), it might indicate that wood by-product is effective for storing breaker tomato for 21 days.

3.4 Lycopene, β-Carotene and Ascorbic Acid Content

The effect of wood by-product on the nutritional contents of breaker tomato during storage is as shown (Fig. 3a). The lycopene contents of stored sample B1, B2 and control (B0) ranged from 3.47–8.20 $\times 10^{-3}$ mg per 100 mL, 3.70–9.43 $\times 10^{-3}$ mg per 100 mL and 1.80-6.40 $\times 10^{-3}$ mg per 100 mL respectively. Significant ($p<0.05$) increase was recorded for the treated samples against the control sample where there was a significant ($p<0.05$) decrease in the lycopene content between day 0 and 28 while the storage lasted.

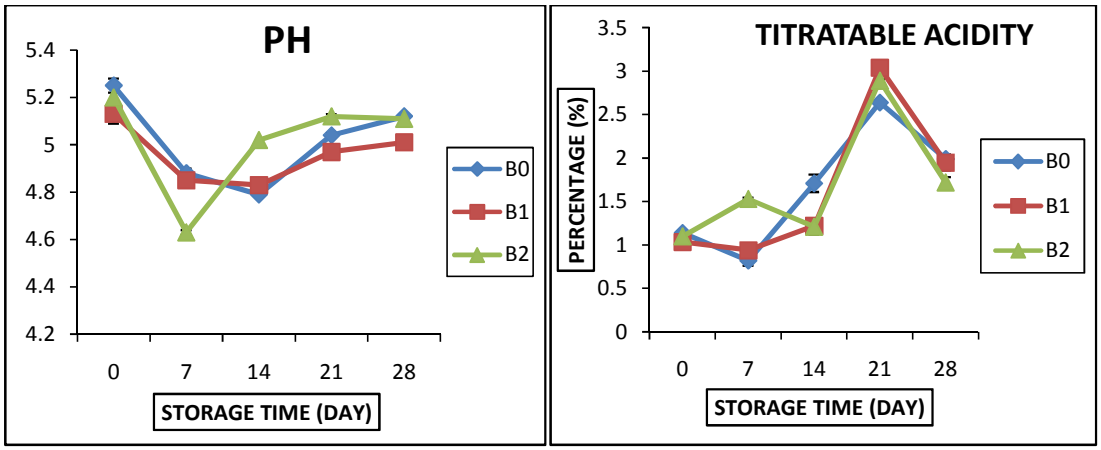

Fig. 2. Storage effect of wood ash treatment on the pH and Titratable acidity of breaker tomato (*Solanum lycopersicum*L.) after 28 days

Lycopene is the major carotenoid compound present in tomatoes and it's responsible for the characteristic red colour of ripe tomatoes [8]. Chlorophyll pigment decreases as the fruit ripens which in turn leads to an increase in the synthesis of lycopene, thus, lycopene content is expected to increase as the storage time increase [19].

The ascorbic acid (Vitamin C) contents of breaker tomatoes after treatment with wood by-product for a storage period of 28 days as reported (Fig. 3b). The ascorbic acid contents of control, B1 and B2 ranged from 9.64-36.16 mg per 100 g, 16.83-49.25 mg per 100 g and 13.51-36.09 mg per 100 g respectively. There was no significant ($p>0.05$) difference between the ascorbic acid contents of the control B1 and B2 at day 0 whereas, at day 28 the ascorbic acid contents of sample B1 was significantly ($p<0.05$) higher than B2 and control. The ascorbic acid content of sample B1 as reported in the present study fall within a close range with data obtained from the literature [21].

The β-carotene content of the treated and control samples are as shown (Fig. 4). The carotene contents control, sample B1 and B2 ranged from 0.014–1.516 $\times 10^{-2}$ mg per 100 mL, 0.013–1.364 $\times 10^{-2}$ mg per 100 mL and 0.012–1.456 $\times 10^{-2}$ mg per 100 mL respectively. No significant ($p<0.05$) difference was observed in the β-carotene of control, B1 and B2 at day 0. This can be attributed to the fact that all the samples came from the same source. At day 28, the β-carotene content of B1 was significantly ($p<0.05$) higher than control and B2.

3.5 Moisture Content (MC), Total Soluble Solids (TSS) and Sugar-Acid Ratio

The moisture content (MC) of control, treatments B1 and B2 were as shown (Table 2). The moisture content of B0, B1 and B2 were 89.26-92.34, 89.64-92.34 and 89.54-92.19% respectively. The MC of sample B2 was significantly ($p<0.05$) higher than control at day 0 whereas at day 28, there was no significant ($p>0.05$) difference in the MC of the control and sample B2. The data recorded showed that there was no significant ($p>0.05$) difference in the MC of the control and sample B1 at day 0 and 28. Reduction in MC of sample B2 at day 28 could be explained from the point of view of the particle nature (Nano-sized) of wood ash which tends draw water from its surrounding.

The effect of wood by-product on soluble solid (SS) of breaker tomatoes during storage was as reported (Table 2). The SS values observed for the period of study were 6.8-8.53 ^{0}Brix, 6.2-8.96 ^{0}Brix and 6.47-8.33 ^{0}Brix for control, B1 and B2 respectively. There was no significant ($p>0.05$) difference between the soluble solid content of the control, B1 and B2. The soluble solid content of sample B1 was significantly ($p<0.05$) higher than both control and B2 at day 28.

The effect of wood by-product on the Brix-Acid ratio was as presented (Table 2). The Brix-Acid ratio of the control, B1 and B2 were 2.81-8.80, 2.95-6.50 and 2.53-6.56 respectively. There was no significant ($p>0.05$) difference between the Brix-Acid at day 0 and 28. Brix-Acid is an important factor for quality parameters of tomato

fruits as it is known that sweetness and sourness play an important role in the flavour of tomatoes. This contributes to the sensory attributes of the fruit [22].

3.6 Mineral Composition

The breaker tomato samples (initial sample before storage, control and treated) and the wood by-product used for the storage purpose were subjected to mineral analysis to determine the mineral constituents (Table 3). The minerals analysed for in the samples comprise of micro elements, macro elements and some heavy metals. These include; Sodium (Na), Potassium (K), Calcium (Ca), Zinc (Zn), Iron (Fe), Magnesium (Mg), Manganese (Mn), Copper (Cu), Lead (Pb), Cadmium (Cd) and Chromium (Cr). The result indicated that Na, K, Zn, Fe, Cu, Ca, Mn and Mg mean values ranged from 6.13-8.03, 77-91.83, 0.07-0.30, 0.02-2.46, 0.01-0.05, 0.03-70.87, 0.02-0.33 and 1.05-18.09 mg/100 g respectively. Pb, Cd and Cr were not detected in any of the samples, both treated and untreated, as well as the wood by-product. Sodium/Potassium ratio as indicated in the result ranged from 0.0786-0.0947. Ca and Mn were not detected in initial breaker tomatoes. Also, Cu was not detected in the treatment B1. K content of wood ash showed no significant difference ($p>0.05$) with that of initial breaker tomato but showed a significant difference ($p<0.05$) with that

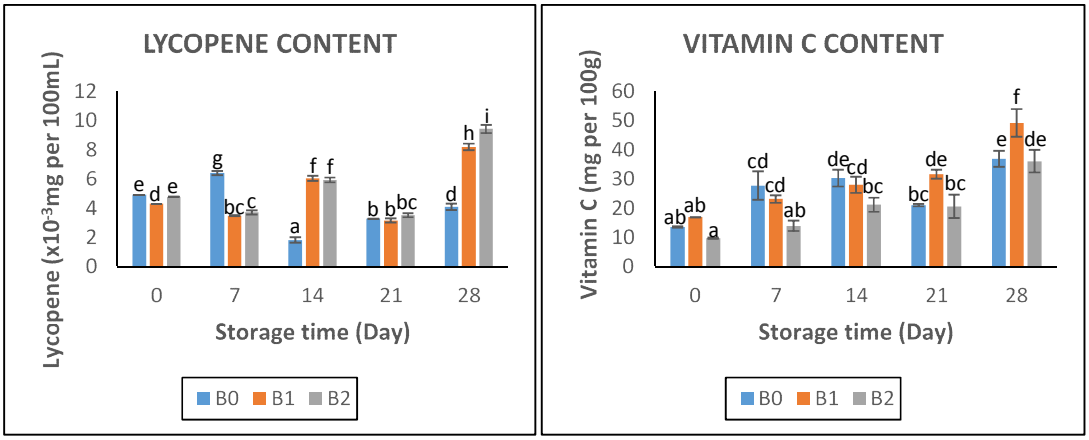

Fig. 3. Storage effect of wood ash treatment on Lycopene and Vitamin C contents (mg/100 g) of breaker tomatoes. B0 is control; B1 is 1:1 (wood ash to tomato); B2 is 2:1 (wood ash to tomato). Error bars represent standard error (SE) of the mean

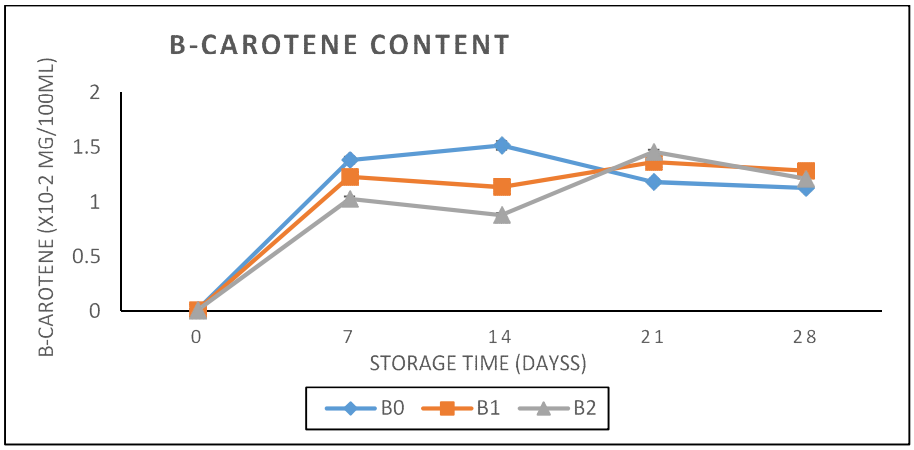

Fig. 4. Storage effect of wood ash treatment on β-Carotene content (mg/100 g) of breaker tomato. B0 is control; B1 is 1:1 (wood ash to tomato); B2 is 2:1 (wood ash to tomato). Error bars represent standard error (SE) of the mean

Table 2. Storage effect of wood ash treatment on the Moisture content, total soluble solids and sugar/acid ratio of breaker tomato (*Solanum lycopersicumL.*) after 28 days

Sample	Day	Moisture content (%)	Total soluble solids (brix)	Sugar/acid ratio
B0		91.09^{a}	6.80^{bc}	5.93^{ef}
B1	0	91.69^{ab}	6.47^{ab}	6.28^{ef}
B2		92.19^{b}	6.47^{ab}	5.88^{ef}
B0		91.95^{a}	7.20^{cd}	8.80^{g}
B1	7	92.34^{a}	6.20^{a}	6.50^{f}
B2		90.94^{a}	6.80^{bc}	4.53^{cd}
B0		89.26^{a}	8.53^{ef}	5.02^{d}
B1	14	91.19^{b}	6.96^{bcd}	5.69^{e}
B2		89.54^{a}	7.96^{e}	6.56^{f}
B0		89.28^{a}	6.90^{bcd}	3.46^{b}
B1	21	89.64^{a}	8.10^{e}	4.16^{c}
B2		89.69^{a}	8.33^{e}	4.86^{d}
B0		90.49^{a}	7.40^{d}	2.81^{ab}
B1	28	91.51^{b}	8.96^{f}	2.95^{ab}
B2		89.58^{a}	7.30^{cd}	2.53^{a}

Results showed Mean ± SE of Moisture content, total soluble solids and Sugar/Acid ratio of breaker tomatoes after a storage period of 28 days. Means with unshared superscript in the same row are significantly (p<0.05) different. B0=control, B1=ratio 1:1 (tomato: wood ash), B2=ratio 1: 2 (tomato: wood ash)

Table 3. Effects of wood ash treatment on the mineral composition of breaker tomatoes

Minerals (mg/100 g)	Ash	B	B0	B1	B2
Sodium (Na)	7.23±0.00^{c}	6.13±0.03^{a}	8.03±0.03^{e}	6.63±0.03^{b}	7.33±0.03^{d}
Potassium (K)	76.33±0.33^{a}	77±0.33^{a}	91.83±1.33^{c}	84.33±0.33^{b}	91.67±1.67^{c}
Zinc (Zn)	0.30±0.00^{e}	0.10±0.00^{b}	0.13±0.01^{c}	0.07±0.01^{a}	0.19±0.01^{d}
Iron (Fe)	2.46±0.01^{e}	0.02±0.00^{a}	0.09±0.00^{c}	0.07±0.00^{b}	0.15±0.00^{d}
Copper (Cu)	0.04±0.01^{b}	0.01±0.00^{a}	0.04±0.00^{b}	ND	0.05±0.00^{b}
Calcium (Ca)	70.87±0.07^{d}	ND	0.07±0.03^{c}	0.27±0.03^{b}	0.03±0.00^{a}
Manganese (Mn)	0.29±0.01^{c}	ND	0.05±0.01^{b}	0.02±0.00^{a}	0.33±0.07^{ab}
Magnesium (Mg)	18.09±0.01^{e}	1.05±0.02^{a}	1.85±0.01^{c}	1.62±0.02^{b}	12.39±0.01^{d}
Lead (Pb)	ND	ND	ND	ND	ND
Cadmium (Cd)	ND	ND	ND	ND	ND
Chromium (Cr)	ND	ND	ND	ND	ND
Sodium/Potassium ratio	0.0947	0.0796	0.0874	0.0786	0.0799

Results showed Mean ± SE of duplicate readings (n=2). Means with unshared superscript in the same row are significantly different (p<0.05). ND=not detected; Ash=medium; B=Breaker tomato before storage; B0=control; B1=1: 1 (tomato: wood ash); B2=1: 2 (tomato: wood ash)

of the control and treated breaker tomato samples. No significant difference (p>0.05) was observed in the K contents of the control (B0) and the treatment (B2). Na, Zn, Fe, Ca, and Mg showed significant difference (p<0.05) between all groups of treated samples, the control, initial breaker tomato and the wood by-product used as a storage medium with the values ranging from 6.13-8.03 mg per 100 g, 0.07-0.30 mg per 100 g, 0.02-2.46 mg per 100 g, 0.03-70.87 mg per 100 g and 1.05-18.09 mg per 100 g respectively. The Mn content recorded for treatment B2 was found to share no significant difference (p>0.05) with treatment B1 and control (B0), however, wood ash recorded the highest concentration of Mn with 0.29 mg per 100 g. The Cu content of initial breaker sample was significantly lower (p<0.05) than other breaker tomato groups which shared no significant difference (p>0.05) with the wood by-product used for storage. The result showed that wood ash contained no trace of Cd, Cr and Pb, which further confirmed the claim of [7] that wood ash doesn't contain high concentration of heavy metals that pose a risk of secondary contamination.

4. CONCLUSION

This study has revealed that treatment of breaker tomato with wood by-product has demonstrated

good storage properties especially in sensory attributes and some physicochemical parameters such as moisture or weight loss, decay incidence and nutritional qualities such as lycopene, vitamin C and β-Carotene. Treatments with equal portions of wood by-product (B1) have shown great storage indices than double portion (B2) and control in most of the parameters analysed. The study also showed that storage with wood by-product showed no risk of cross contamination with the stored fruits. It can therefore be concluded that wood by-product treatment, as demonstrated in the present study, is a safe medium for storing breaker tomatoes for a period of 28 days at ambient condition (29°C temperature, 70% relative humidity).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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